VEBE. A Computer Model for Simulation of Conventional Weapons Effects in Urban Areas.

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Abstract

VEBE is a computer model developed by FOA for simulation of conventional weapons effects in urban areas. The model is still under construction but there is already an operational first version running. This first version has also been used in studies for the Swedish National Rescue Services Board (SRV). VEBE has been developed and used on a workstation but there is also a PC version running.

The model will also, in a later version, simulate other types of weapons effects and different types of manmade peacetime disasters such as vapour cloud explosions.

VEBE can be used in studies of damage prevention, studies of rescue activities, in education on different levels of the civil and military defence and in planning within both central and local authorities.

In VEBE it is possible to use the total map of a small town or the map of a part of a major city as input.

When the objective of the weapon attack has been chosen the computer helps the user to choose the appropriate type of attack and the type of weapon from a code menu.

Both air attacks and surface combat can be handled by the model.

The computer calculates the points of weapon impact, the penetration of the weapons into buildings or into the ground and the damage from blast, fragments, debris and fire.

The output data are the number of casualties (both dead and injured persons and the casualty cause), the number and severity of damaged buildings and shelters, the amount and location of debris, the limitations of availability due to craters and debris, the damaged supply systems (water, heat, electricity and telephone) and finally the fires with their growth displayed as a function of time.

Introduction

Calculations of the damage to buildings and people in urban areas from conventional weapons have been made in Sweden for several years. The purpose has been to give a view of the situation after an attack, that can be used in planning of civil defence activities, studies of damage prevention and rescue activities, and also in education on different levels of the civil and military defence. The calculations have been supported by extensive theoretical and

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experimental research concerning different phenomenas of loading from weapons and response from such loadings to urban areas. In the beginning the calculations were made manually for instance of the damage after an attack of airplanes against a railwaystation surrounded by dwelling houses. Calculations made manually are very timeconsuming and that makes it very difficult to study the effects of parametric variations.

Some years ago work was initiated to develop a computer code - VEBE, that made it possible to quickly make repeated calculations with variations of for instance type of attack, type of weapon, target and target surroundings.

Using a computer code often gives the operator a false belief of the accuracy of the results. It is very important to be aware of that a code like VEBE do not give the absolute truth and that the accuracy is ruled by the accuracy of the input data and the subroutines in the code. VEBE should therefore be used as one among other tools in decisionmaking.

Characteristics of VEBE and how to use it

VEBE has been developed and used on a workstation but there is also a PC version running. The total size of the executable files are approximately 2 MB and approximately 10 MB for the data files in a typical run. The programme language is ADA.

Running VEBE starts with choosing the map of a small town or a part of a mayor city and the data for this area is previously stored on the hard disk. The data contains coordinates in two dimensions for the buildings, streets and supply of water, sewerage, heat, electricity and telephone. This data has previously been transformed from data, digitally available for several districts in Sweden. Some data has been surveyed on site and then stored into the computer. Such data are for instance the types of the buildings (22 types have been defined according to framework and materials used [1],[2]), the height and number of stories, and if there are basements and attics. For houses that are not for dwelling, also the use of the building is surveyed and stored. Data about the civil defence shelters is also read into the computer.

After the choice of the map the simulation is started by giving information about the attack. First the computer asks the operator to mark the target and the direction of the attack. Then information of the phase of the war (if it is in early or late stage) is required as a base to the computers suggestion of type of the attack, which can be from the ground or from the air, and what type of weapons and weapon platforms there are used. For airplanes the height and velocity are also put in. The suggestion from the computer can be accepted or changed arbitrarily. The weapons are described by a number of parameters such as type, diameter, total weight, weight of high explosive, nose shape and fuse time delay. All this is stored in databases in the program and can be accepted or changed arbitrarily.

Next step in the simulation is to position the people. To start with, it is possible to choose night or day-time for the attack which gives different total numbers of people in the area. It is now possible to place the people manually by clicking in the map for each person or to choose a more standardized procedure. It is for instance possible to choose placing all or parts

of the people outdoors, indoors in the apartments, in the basements or in the shelters.

There are two ways of doing the simulation. Either a single run can be done and it is then possible to study where the explosions take place, the damage from the explosions and the damage from the fire and smoke (Figure 1). When a single run is made it is also possible to choose different overlays, with information about supply systems for instance, or to zoom in the map. It is also possible to click on a specific building to get a plan and a crossection where the damage are shown in different zones (Figure 2).

It is also possible to choose a number of runs in a row with the same situation. For each run the hit points are randomized according to certain rules of scatter. The result of this type of repeated runs will be a list of average values of results.

Output data from VEBE

The output data from VEBE concerns damage to buildings, ground, supply systems in the ground and people.

The damage to buildings due to blast and fragments is shown with a number of damage zones:

- floor collapse zone (closest to an explosion inside, where the floors have collapsed)
- wall collapse zone (zone further out from the explosion than floor collapse zone, where the load bearing walls have collapsed)
- crack zone (zone where there are cracks through load bearing walls)
- shake zone (zone where non load bearing walls are damaged)
- debris fall zone (zone outside buildings where the debris has fallen down)
- debris throw zone (zone outside buildings where debris has been thrown)
- window breaking zone (area where more than 50% of the windows are broken)

The damages to supply systems in the ground such as water, sewerage, heat, electricity and telephone are also shown as are the crater dimensions.

The damage from fire and smoke is also divided into different damage zones:
- fire zone (where there is open fire)
- smoke zone (smoke filled volumes)
- cooling zones (a few different are shown with characteristic temperatures)

The damage from fire and smoke change by time and it is possible to stop after for instance every 5 minutes starting from the hit of the weapons and evaluate the damage.

The output data from the program concerning injury to people are the number of casualties. Both dead and injured are calculated and listed according to the cause who are:

- blast

- shrapnels
- debris from the building
- window glass fragments
- fire
- smoke

Calculations in VEBE submodels

The actual calculations in VEBE start with determining the hit points. The hit points are randomized in an area with size depending on the type of weapon, the distance from the weapon platform to the target and if the weapons come from an airplane the velocity and height of the airplane and also the modernity of the aerial aiming device [3,4,5].

Next step is to calculate the depth of penetration into the buildings or the ground [3,4,5,6]. The fuse may be set with one of three different time delays:

- no time delay
- short time delay (ignition after first penetration of floor or wall)
- long time delay (ignition after weapon has stopped)

After the point of explosion for each warhead has been calculated the damage to buildings is calculated. If the explosion is outside, above ground, the damage will depend on the blast wave pressure, the impulse density and loading from the shrapnels [3,4,5,7]. Damage from explosion inside is calculated according to rules determined by help of the computer code PROMIX [3,4,5,8]. The smallest unit used in the calculations are not the single rooms but something called framework unit, which is the volume limited by loadbearing walls.

Damage due to explosion underground to supply, buildings and crater dimensions is ruled by fairly simple handbook methods [3,4,5,9].

A submodel describes the fire and smoke spread [3,4,5]. The fire may, besides internal spread inside the buildings, also spread between buildings due to heat radiation or firebrands.

One submodel in the calculations of injuries to people concerns blast [3,4,5,10]. The numbers of injuring and lethal fragments at different distances are based on calculations of shell breakup, fragment initial velocity, trajectory, and injury criteria [3,4,5,11].

Casualties due to debris from the buildings including window glass fragments as well as casualties due to smoke and fire are connected to the damage zones and based on rather simple rules derived from accidents and war time experience [3,4,5].

Summary and future development

VEBE is a computer model developed by FOA for simulation of conventional weapons effects in urban areas.

A lot of efforts has been made to give a good picture of the damage to a built-up area with possibilities to zoom in and to study a single building both in plan and cross section.

With VEBE it is simple to make parametric variations.

VEBE has already been used in several studies of war time civil defence organization and also in studies of benefit with civil defence shelters.

VEBE can be used to identify the phenomenas that are the most important in conventional weapon attacks in urban areas. It can thus be used as a tool to guidance of which areas of research are most important.

It is very important to be aware of that a code like VEBE do not give the absolute truth by any means. VEBE should be used only as a tool among others. The accuracy is ruled by the accuracy of the input data and the subroutines in the code.

There are plans to develop VEBE in several ways for instance to make it possible to simulate the effects of other types of weapons such as chemical weapons. There are also plans to make it possible to simulate manmade peacetime disasters such as vapour cloud explosions.

Another use of VEBE that has been discussed is to simulate the damage from explosions in ammunition magazines.

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Figure 1. A map showing a part of the swedish town Umeå, with VEBE simulated hit points after an aerial attack.

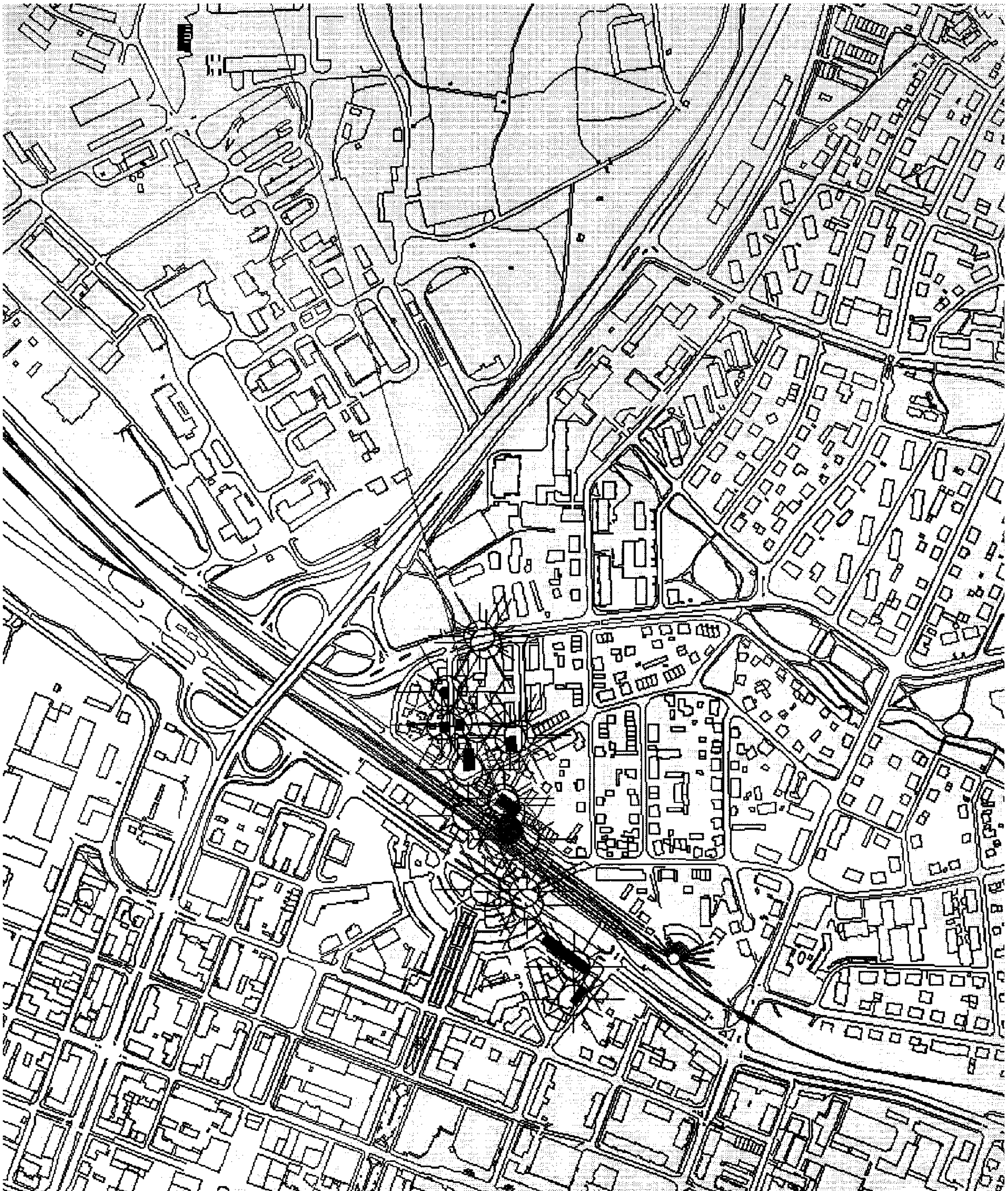

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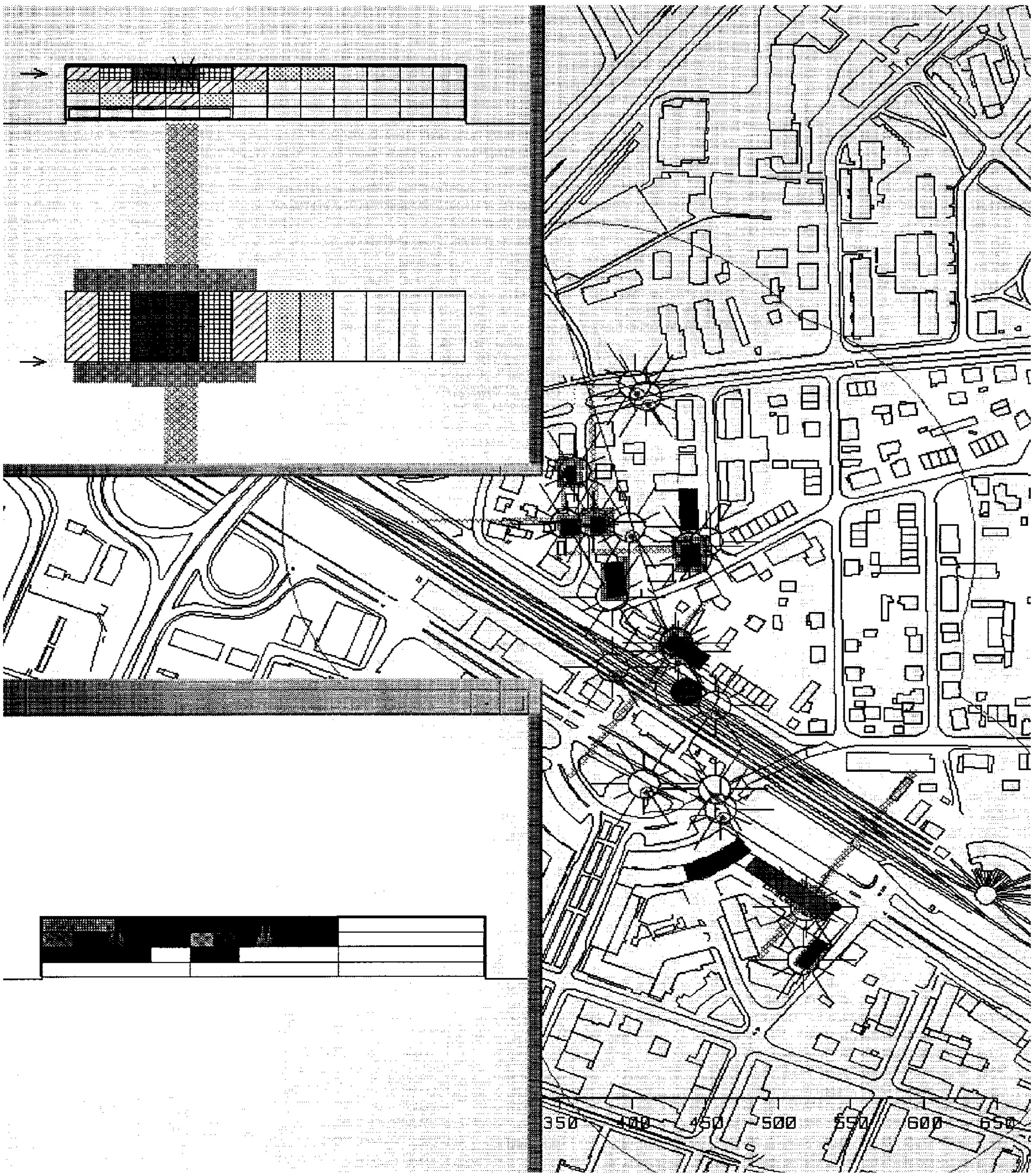
Figure 2. The map from Figure 1 has been zoomed in and plan and cross sections for one of the buildings are displayed. The upper cross section and plan show the damage from blast and fragments. The lower cross section shows the fire and smoke spread after 30 minutes.



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